

(12) UK Patent Application (19) GB (11) 2 296 132 (13) A

(43) Date of A Publication 19.06.1996

(21) Application No 9424987.7

(22) Date of Filing 12.12.1994

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(51) INT CL⁶
H05K 7/20

(52) UK CL (Edition O)
**H1R RBK
U1S S2139 S2203**

(56) Documents Cited
**GB 2280989 A GB 1018623 A WO 93/06340 A1
US 4103737 A**

(58) Field of Search
**UK CL (Edition N) H1R RBK
INT CL⁶ H05K 7/00 7/20
Online:WPI**

(54) Cooling electrical apparatus

(57) A cooling system for electrical apparatus 4 has a cooling fan 1 which causes air to pass over the apparatus from an air inlet port to an air outlet port 8 through a duct or passageway 3 whose effective volume reduces from the inlet port to the outlet port.

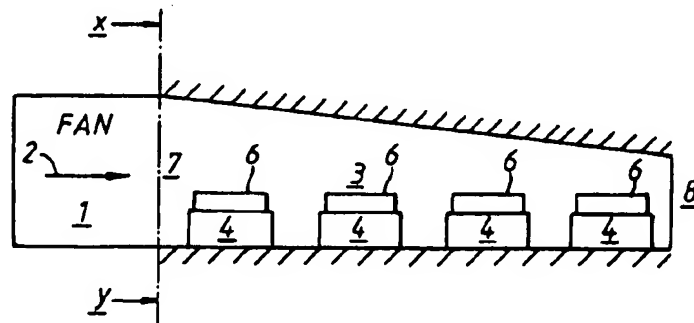


Fig.1

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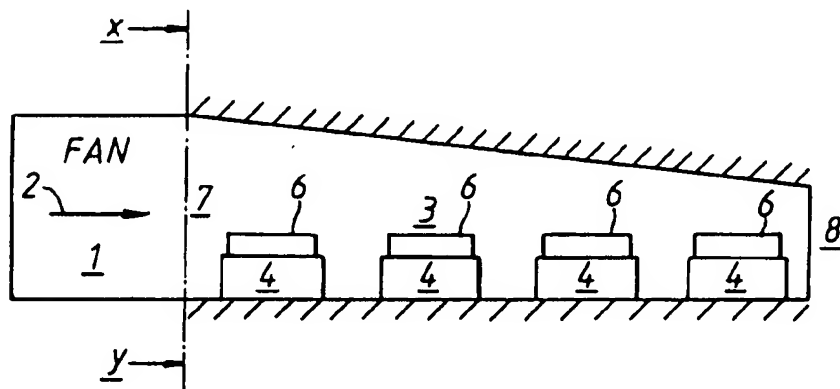


Fig. 1

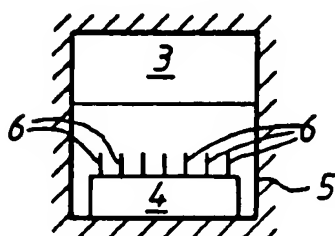


Fig. 2

IMPROVEMENTS IN OR RELATING TO COOLING SYSTEMS

This invention relates to cooling systems and more especially although not exclusively it relates to cooling systems for electronic or electrical apparatus.

In operation, electronic apparatus generates heat and for some applications it is necessary to provide a cooling system which serves to prevent the temperature to which electronic components which form a part of the apparatus are subjected, rising above a predetermined upper limit. The cooling of electronic apparatus, which comprises closely packed devices, can be a particular problem especially when high power dissipation is involved. In known systems temperature is sometimes effectively controlled by providing, in operative association with electronic devices which dissipate heat, cooling fins over which cool air is blown by means of a cooling fan.

One of the problems however with known cooling systems is that the air used for cooling purposes becomes progressively heated as it passes over electronic apparatus to be cooled from an inlet port to an outlet port, whereby the cooling effect, which is thereby provided, is progressively reduced between the ports. Thus in a rack of electronic apparatus for example, those parts of the apparatus which are positioned near a cooling air inlet may be suitably cooled, whereas those parts of the apparatus positioned near a cooling air outlet may not be cooled sufficiently because the air which passes over them has in effect been preheated by the apparatus near the inlet port over which it has previously passed.

It is an object of the present invention to provide a cooling system in which the foregoing problem is at least to some extent overcome.

According to the present invention a cooling system for apparatus comprises a cooling fan which is arranged to cause air to pass over the apparatus from an air inlet port to an air outlet port through a duct or passageway within which the apparatus is positioned, the duct or passageway being formed so that its effective volume reduces from the inlet port to the outlet port.

By arranging that the volume reduces between the inlet and outlet ports, it follows that the air flow velocity therebetween will increase correspondingly as the volume decreases whereby the cooling effect throughout the length of the duct or passageway can be arranged, at least to some extent, to be linearised.

Although the apparatus may take any form the invention is eminently suitable for cooling electronic apparatus comprising electronic devices which dissipate significant power.

Such devices are commonly mounted on printed circuit boards in racks and therefore lend themselves to cooling by means of air which is constrained to move through a duct or passageway in which the racks are positioned.

The devices may form a part of an active array antenna for a radar system.

In order to provide a progressive volume reduction it may be arranged that a wall or walls of the duct or passageway taper from an air input port end to an air output port end thereof.

One embodiment of the invention will now be described by way of example only with reference to the accompanying drawing in which:

Figure 1 is a somewhat schematic sectional side view of an arrangement of electronic devices mounted in a cooling duct and wherein;

Figure 2 is an end view of the arrangement shown in Figure 1 on the broken line xy.

Referring now to Figure 1 the arrangement comprises a fan 1 which is used to blow cooling air in the direction indicated by an arrow 2 through a duct or passageway 3 in which devices 4 to be cooled are mounted on a printed circuit board 5. As shown more clearly in Figure 2 the devices 4 are provided with a heat sink which embodies cooling fins 6. In operation cooling air is driven by the fan in the direction of the arrow 2 so as to be forced through the duct or passageway 3 from an input port 7 to an output port 8.

It will be apparent that in this example the volume of the duct or passageway 3 reduces progressively from the inlet port 7 to the outlet port 8. It will therefore be appreciated that the air velocity will increase progressively along the duct or passageway 3 from the inlet port 7 to the outlet port 8 as the volume decreases, thus enhancing the cooling effect whereby it can be arranged that the cooling effect is approximately linearised throughout the length of the duct or passageway.

By using a tapered duct, temperature differentials vary along the duct allowing a smaller quantity of air to be used. This

will reduce pressure losses, the size and power of fan required, and the duct sizes between the fan and equipment to be cooled. By applying the invention to radar active array antennas more elements may be used and performance improved.

The foregoing embodiment is intended to serve as an example only and various modifications may be made without departing from the scope of the invention. For example, although as shown in Figure 1 the volume tends to decrease linearly, other configurations are envisaged in accordance with the particular application in view. Thus, for example constrictions in the duct may be formed where hot spots are to be found so that in these regions higher air velocity obtains whereby improved cooling is afforded.

CLAIMS

1. A cooling system for apparatus comprising a cooling fan which is arranged to cause air to pass over the apparatus from an air inlet port to an air outlet port through a duct or passageway within which the apparatus is positioned, the duct or passageway being formed so that its effective volume reduces from the inlet port to the outlet port.
2. A cooling system as claimed in Claim 1 wherein the apparatus is electronic apparatus comprising electronic devices which dissipate significant power.
3. A cooling system as claimed in Claim 2 wherein the devices are mounted on a printed circuit board or boards in racks, which racks are mounted in the said duct or passageway.
4. A cooling system as claimed in any preceding Claim wherein a wall or walls of the duct or passageway are arranged to taper from the said input port to the said output port.
5. A cooling system as claimed in Claim 3 or Claim 4 wherein the printed circuit board or boards define at least a part of one wall of the said duct or passageway.
6. A cooling system as claimed in any of Claims 2 to 5 wherein the said devices are provided with heat sinks which include

cooling fins, which fins are arranged to project into the said duct or passageway.

7. A cooling system as claimed in Claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

8. An active array antenna for a radar system including a cooling system as claimed in any preceding claim which is used to cool active elements of the array.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9424987.7
Relevant Technical Fields (i) UK Cl (Ed.N) H1R (RBK) (ii) Int Cl (Ed.6) H05K 7/00, 7/20	Search Examiner J DONALDSON
	Date of completion of Search 20 FEBRUARY 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1 to 8

Categories of documents

X: Document indicating lack of novelty or of inventive step.	P: Document published on or after the declared priority date but before the filing date of the present application.
Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.	E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A: Document indicating technological background and/or state of the art.	&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
X,E	GB 2280989 A (FUJITSU) see page 22, line 31 - page 23, line 16, page 28, line 19 - page 31, line 11	1-6
X	GB 1018623 (G.E.C.) see page 2, lines 18-35, page 3, lines 60-74	1-3, 5, 6, 8
X	WO 93/06340 A1 (BENTON) see page 7, lines 1-22	1-6, 8
X	US 4103737 (PERKINS) see column 2, line 31 - column 4, line 51	1-6, 8

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